DPD

Director's Rule 6-2006

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City of Seattle Department of Planning and Development	1 of 7	N/A
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Repair of Earthquake-Damaged Buildings	**Type of Rule:** Code Interpretation	
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Index: Building Code/Technical Requirements	**Approved** (signature on file) Diane M. Sugimura, Director, DPD	**Date** 4/29/06

1. Background.

The purpose of this Rule is to clarify the requirements for earthquake strengthening for all buildings that are damaged by earthquake. It is intended to make use of commonly-used standards such as those promulgated by ASCE and FEMA.

Earthquake repair is divided into four levels, varying according to the cost of the repairs. Each level of repair has different objectives, and those objectives are cumulative—each level is expected to achieve the objective of the level below with new objectives added.

- An objective for minor and all other repairs is to repair the current damage to structural elements and fire/life safety systems

- Another objective for all earthquake-damaged buildings is to reduce the hazard of unbraced parapets and building appendages that could be shaken loose from the building in the event of an earthquake.

- The objective for moderate repairs (10–30% damage ratio) is to repair the damaged portions of the building in order to reduce but not prevent hazards from building collapse.

- The objectives for significant repairs (30–50% damage ratio) is to increase the likelihood that occupants will be able to exit the building safely after an earthquake, and to reduce the risk of life loss and injury in unreinforced masonry buildings.

- The objective for extensive repairs (>50% damage ratio) is to improve the building's performance with respect to life safety after an earthquake. This objective does not require that the building be brought up to current code standards for new construction. The requirements for extensive repairs are intended to address the most immediate concerns regarding global and local stability. The repaired building may be severely damaged by a future design basis earthquake, and it may have to be demolished, but it should not collapse.

ASCE 31 is the standard used for seismic evaluation of existing buildings. Even though ASCE 31 uses the maximum considered earthquake as the basis for evaluations, a design basis earthquake is used in this Rule for most levels of work because ASCE 31 commentary allows the building official to use a lesser earthquake when appropriate. (See ASCE 31 C3.5.2.3.1.) ASCE 31 describes the maximum considered earthquake (MCE) as an "extreme rare earthquake".

The building official has identified factors that make the lesser earthquake appropriate for this Rule. Given the rarity of the MCE, which in the Pacific Northwest has a return period of 2,500 years, economic and social factors take on more importance. First, almost all buildings built before 2004 were designed with a different understanding of local seismicity. Requiring repair of earthquake damage to meet a higher standard would be difficult, and impossible in some cases. Second, it would be especially onerous to impose the additional economic burden on building owners already impacted by the natural disaster. Third, the additional economic burden has the potential for blight in areas of the City due to the aggregate effect of earthquake damage to numerous buildings.

2. Definitions and Referenced Standards

2.1 Definitions. The following definitions describe terms used in this Rule.

Damage Ratio is the ratio between the cost of work and the estimated replacement cost of the building, expressed as a percentage. The work includes repair of earthquake damage to structural and fire/life safety systems.

Design Basis Earthquake (DBE). The lesser of an earthquake with a 10% chance of exceedance in 50 years or two-thirds MCE.

Life Safety Performance Level. A post-earthquake damage state that includes damage to structural elements, but the building retains a margin against partial or total collapse. Injuries may occur, but the overall risk of life-threatening injury as a result of structural damage is expected to be low.

Maximum Considered Earthquake (MCE). An earthquake with a 2% probability of exceedance in 50 years.

SBC. Seattle Building Code.

2.2 Standards. The following standards are referenced in this Rule.

ASCE 31. Seismic Evaluation of Existing Buildings, ASCE Standard No. 31-03 published by American Society of Civil Engineers

FEMA 356. Federal Emergency Management Agency Prestandard and Commentary for the Seismic Rehabilitation of Buildings (November 2000)

FEMA 306. Evaluation of Earthquake Damaged Concrete and Masonry Wall Buildings: Basic Procedures Manual

FEMA 307 Evaluation of Earthquake Damaged Concrete and Masonry Wall Buildings: Technical Resources

FEMA 308 Repair of Earthquake Damaged Concrete and Masonry Wall Buildings

IEBC Appendix A1. International Existing Buildings Code, Appendix A1—Seismic Strengthening Provisions for Unreinforced Masonry Bearing Wall Buildings

3. Categories of Work. For purposes of determining the requirements for repair and rehabilitation of earthquake-damaged buildings, work on buildings is classified into four categories. The categories are based on the damage ratio as defined in Section 2.1 above.

- **Minor work** has a damage ratio of less than 10 percent.
- **Moderate work** has a damage ratio of at least 10 percent but less than 30 percent.
- **Significant work** has a damage ratio of at least 30 percent but less than 50 percent.
- **Extensive work** has a damage ratio of 50 percent or more.

4. Determination of Damage Ratio

4.1. Cost of Work

Cost of work includes repair of earthquake damage to pre-event condition. Work encompassed in the cost includes repairs to structural and fire/life safety systems.

For the purpose of determining the damage ratio, the cost of work includes the estimated current value of all labor and materials whether actually paid or not, shoring, and hazardous materials removal. Design fees, permit fees, realtor fees and other costs not listed need not be included. Damage to adjacent structures caused by the subject building also need not be included.

Cost may be established by bids or estimates prepared by a qualified cost estimator or general contractor, or may be established according to DPD's Fee Subtitle and associated Director's Rules. If bids or estimates are used to establish costs, the values shall either be:

a. determined in the same year as the replacement value of the building is determined; or

b. the local consumer price index shall be used to adjust the bid or estimate values to values appropriate for the year in which the replacement value is determined.

For the purpose of calculating the damage ratio, the current value of labor and materials may be based on the value in effect on the day of the event.

4.2. Replacement Value

Replacement value is the value of construction to replace the building for the existing type of construction and occupancy. Replacement value shall be determined according to DPD's Fee Subtitle and associated Director's Rules. The valuation shall be based on the use specified on the building's Certificate of Occupancy at the time the damage occurs rather than the proposed use. If there is no Certificate of Occupancy for the building, the last documented use shall be used.

5. Seismic Event.

Evaluation of the required work shall be based on the DBE.

6. Requirements for Categories of Work.

Different levels of seismic strengthening are required for each category of work. The table below summarizes the relationships between the work required by this rule and the category of work. The requirements summarized in the table are explained further in the sections of the Rule that follow.

Table 6
Categories of Work

Requirement	Minor Work— up to 10% Section 7	Moderate Work— 10% to 30% Section 8	Significant Work— 30% to 50% Section 9	Extensive Work— 50% or more Section 10
Repair damage to structural elements and fire/life systems	R	R	R	R
Unsafe parapets and other building appendages braced or abated	R	R	R	R
All structures supporting and supported by the damaged portions of the building shall be repaired as specified in Section 8.	NR	R	R	R
Hazards in exits and exit discharges are mitigated	NR	NR	R	R
Limited remediation for unreinforced masonry buildings	NR	NR	R	NA
Life safety performance level at DBE	NR	NR	NR	R

NR = Not Required R = Required NA = Not Allowed

7. Requirements for minor work.

a. Damage to structural elements and fire/life safety systems shall be repaired.

b. New or replaced structural elements shall comply with current code requirements and shall be tied into new or existing structure in accordance with the structural engineer's recommendations and accepted practice. The building official may allow replacement in kind for minor repairs according to SBC Section 3403.8.

c. All structural repairs shall be designed by a structural engineer licensed in the State of Washington.

d. The building official may waive specific items that are impractical in accordance with SBC Section 3403.4.

e. Regardless of the amount of damage to the building, all parapets constructed of unreinforced masonry and other unsafe building appendages shall be evaluated. Parapets and other appendages determined to be deficient shall either be:

(i) braced in accordance with FEMA 356 for Life Safety performance; or

(ii) abated in accordance with SBC Section 3402. It should be noted that many parapets function as required fire walls and are required to remain in place. There may also be restrictions on alteration and removal of parapets on historic buildings.

f. Cracked concrete and masonry shall be repaired where required by FEMA 306, 307 and 308.

g. Historic buildings are also subject to Section 3403.9 of the Seattle Building Code.

h. Work other than earthquake repair shall comply with SBC Chapter 34.

i. Strengthening of the overall structure is not required.

j. Fire protection and safety systems required when the building was built or altered are required to be repaired in accordance with SBC Section 3402.1.

k. No portion of the building shall be altered so that the building becomes less safe than it was before the earthquake, nor shall the work create an unsafe condition as defined in Section 102 of the SBC.

8. Requirements for moderate work. Moderate work as defined in Section 3 above shall comply with the requirements for minor work in addition to this section.

All structures supporting and supported by the damaged portions of the building shall be repaired in accordance with the following requirements.

a. The capacity of existing structural elements supporting and supported by the damaged portion of the building shall not be reduced below the pre-earthquake condition.

b. The lateral loading to existing elements of the seismic force resisting system shall not be increased beyond their capacity.

c. New work shall not introduce new irregularities, and shall not worsen existing irregularities

d. New structural elements shall be detailed and connected to the existing structural elements as required by the SBC.

e. New or relocated nonstructural elements shall be detailed and connected to existing or new structural elements as required by the SBC.

9. Requirements for significant work. Significant work as defined in Section 3 above shall comply with the requirements for moderate work in addition to this section.

a. The engineer shall submit a report identifying structural damage, and falling hazards to exitways, pedestrian walkways and public rights of way. The report shall also contain a statement acknowledging that compliance with this Section may not satisfy the requirements for substantial alteration of SBC Section 3403.12

b. Any identified falling hazards in exits and exit discharges shall be mitigated so as to limit damage at primary means of egress to increase the likelihood that occupants will be able to exit the building safely after a DBE.

c. The walls and floors of unreinforced masonry buildings shall comply with the portions of either Appendix A1 of the 2003 International Existing Buildings Code or ASCE 31 as listed in the table below, using 3/4 of the DBE values with a minimum value of 0.80 for S_{DS} and of 0.35 for S_{D1}.

Table 9
Requirements for Unreinforced Masonry Buildings

Component	ASCE 31 Section	IEBC Section
Masonry strength (mortar and anchor tests) for anchorage to masonry and for wall bracing*	4.2.6.2.2.	A106.3.3
Diaphragm shear transfer	4.2.6.3.2.6	A111.5
Out-of-plane transfer	4.2.6.3.5	A113.1
Wall bracing	4.2.6.3.4	A113.5

* If the tested mortar strength is less than the minimums indicated in these sections, then item 9.c. shall not be permitted to be used, and the structure shall be evaluated in accordance with section 10.

10. Requirements for extensive work. Extensive work as defined in Section 3 above shall conform to the requirements for significant work and the following provisions.

a. The repaired structure shall be designed to satisfy the requirements for life safety performance at the DBE.

b. A seismic evaluation report shall be submitted. The reports shall satisfy the following requirements.

(i) The report shall be prepared by a structural engineer registered in the State of Washington.

(ii) The report shall be based on ASCE 31 or FEMA 356 for Life Safety performance at the DBE. Unreinforced masonry buildings may comply with IEBC Appendix A1. The limitations of Section 9c are not allowed for extensive work.

(iii) At a minimum, the report shall contain the information listed below. A previously-written report may be submitted if it satisfies the requirements of this Rule.

- An overall description of the building, including size (number of stories and basements, approximate floor area) and the occupancies or uses in the building.
- Identification of building deficiencies.
- A prioritized list of recommendations from the structural engineer on how to address the identified deficiencies.
- The seismic evaluation report shall comply with DPD Director's Rule 32-96, Seismic Survey and Report Requirements and CAM 314, Seattle Building Code Requirements for Existing Buildings that Undergo Substantial Alterations.

11. Phasing. The building official may allow extensive work to be done in phases according to an approved plan.

12. Substantial Alterations. When the damage ratio is 30% or higher, repair of earthquake damage will be considered when determining whether SBC Section 3403.12 provisions for substantial alterations apply.